California High-Speed Train Project

Request for Proposal for Design-Build Services

RFP No.: HSR 11-16
Structures Report
Veterans Blvd to Clinton Ave

Prepared for

CALIFORNIA
High-Speed Rail Authority

CALIFORNIA HIGH-SPEED TRAIN

Engineering Report

Merced to Fresno

HST Herndon Canal Bridge

February 2012

CALIFORNIA
High-Speed Rail Authority

U.S. Department of Transportation
Federal Railroad Administration

HST Herndon Canal Bridge

Prepared by:

AECOM

[February] [2012]

1. Existing Conditions

The Herndon Canal is owned and operated by the Fresno Irrigation District (FID) and is part of a network of canals that not only convey irrigation water for agricultural uses eight months of the year, but also provide storm water drainage and groundwater recharge in the Winter months. In the vicinity of the proposed HST track alignment, the Herndon Canal crosses under the City of Fresno's Golden State Boulevard (GSB) in a multi-cell, reinforced concrete (RC) cast-in-place (CIP) box culvert. The existing box culvert consists of a five-bay RC/CIP concrete box and each bay is about 7 feet in width and 5 feet,6 inches in height – see photo below. Upstream of this Golden State Boulevard box culvert is a UPRR bridge over the Herndon Canal which consists of a three-span short bridge – see photo below. Downstream of this Golden State Boulevard box culvert is open channel. The Herndon Canal channel is currently unlined throughout this area.

Herndon Canal Box Culvert at GSB

UPPR Railroad Bridge Upstream (East) of GSB

2. Proposed Structure

The existing RC/CIP box culvert that supports Golden State Boulevard will be removed and replaced with the recommended structure type of Precast/Prestressed concrete box girders to accommodate the proposed HST alignment. Precast/Prestressed concrete box girder bridges have been used successfully since the mid-1950's and are the preferred bridge type for short-span railroad bridges.

Superstructure:

For the preliminary design, a two-span structure is proposed to minimize the depth of the bridge superstructure and ease the track profile due to vertical clearance constraints (i.e., maximize the structure's clearance height over the canal and minimize the HST's track height). An intermediate support is proposed in the center of the canal channel that results in two structure spans of 32 feet each. The girders will be designed as simply supported, allowing prefabricated structural elements to be brought in and lifted into place at the site in a short period of time. This solution alleviates the need to cure concrete in the field and allows a shorter construction window than a cast-in-place structure. The bridge structure will be required to support double

tracks with a structure width of 43 feet. A standard 42-inch deep PC/PS double-cell concrete box girder is proposed.

Substructure:

The recommended support elements for the Herndon Canal bridge will consist of reinforced concrete abutments at each end, with an intermediate cast-in-place concrete pier wall with an enlarged bent cap capable of supporting the bridge girders. All of the substructure elements will be founded on Cast-in-Drilled-Hole (CIDH) piles and pile caps. CIDH piles are recommended to support the proposed bridge Bent 2 and Abutments, with diameters of 30 inches and 24 inches, respectively.

Freeboard:

FID requires a minimum freeboard of 2.0 feet for any new canal crossing. The existing GSB box culvert provides a very limited freeboard from the high-water elevation to the soffit of the box culvert. This 2.0 feet of freeboard is needed to allow floating debris and channel flow to pass through the waterway opening provided by the bridge minimizing the potential for the accumulation of debris that may obstruct flow. The proposed HST Herndon Canal bridge will have a minimum of 2.0 feet of available freeboard from the canal's high-water elevation to the soffit of the bridge.

Pier/Trash Riders:

Per FID standard details, pier/trash riders are required on the upstream sides of the center pier wall of the bridge. The minimum wall thickness shall be 6"x 12" as shown in the attached drawings with an appropriate slope.

Channel Lining:

FID requires the channel to be concrete lined through the structure within the proposed HST Authority ROW, with rip rap required to be placed in the transitions to this concrete lining as shown in the attached drawings and as specified in the FID standards.

Construction Limitations:

According to FID, the irrigation season typically runs from mid-February to October, but dates may vary. The contractor will need to contact FID with regard to the end of FID's irrigation season and secure construction encroachment permits from them. Construction work in the canal channel is generally carried out between the irrigation and the flood seasons in November and December. The Herndon Canal will remain operational and be used to route water outside the normal irrigation season.

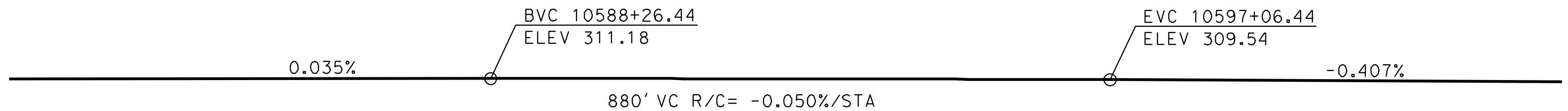
Removal of the existing structure and construction of the new HST bridge is expected to occur during the winter months, when only minimal flows are anticipated. The site will need to be dewatered during construction of the foundations and the lining of the channel. While typical

maintenance flows range from 50-75 cfs, the canal is used to convey storm water when required. FID has agreed that a bypass facility with a capacity of 200 cfs would be reasonable during the construction period.

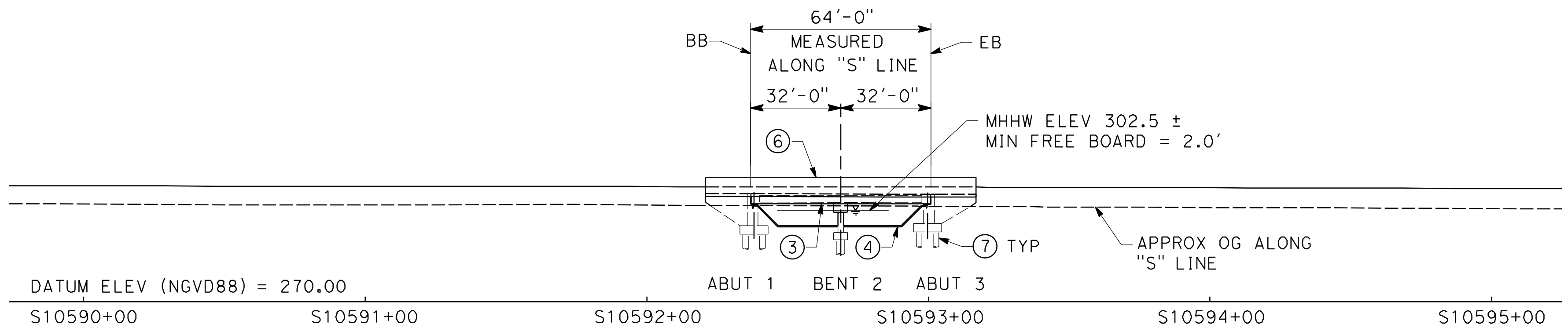
<u>Utilities:</u>
A 4"gas line and a 14" water pipe line are observed to be running parallel to the upstream (east) side of the edge of the existing GSB box culvert. These utilities must be relocated before the demolition of the existing GSB box culvert and the construction of the new HST canal crossing structure.

<u>Traffic Handling:</u>
Traffic on Golden State Boulevard cannot be maintained while constructing the new HST Bridge over the Herndon Canal. Therefore a new Golden State Boulevard bridge over the Herndon Canal will be constructed on a new roadway alignment west of the existing box culvert prior to the removal of the existing Golden State Boulevard box culvert over the canal, and the Golden State Boulevard traffic shifted to the completed new roadway bridge.

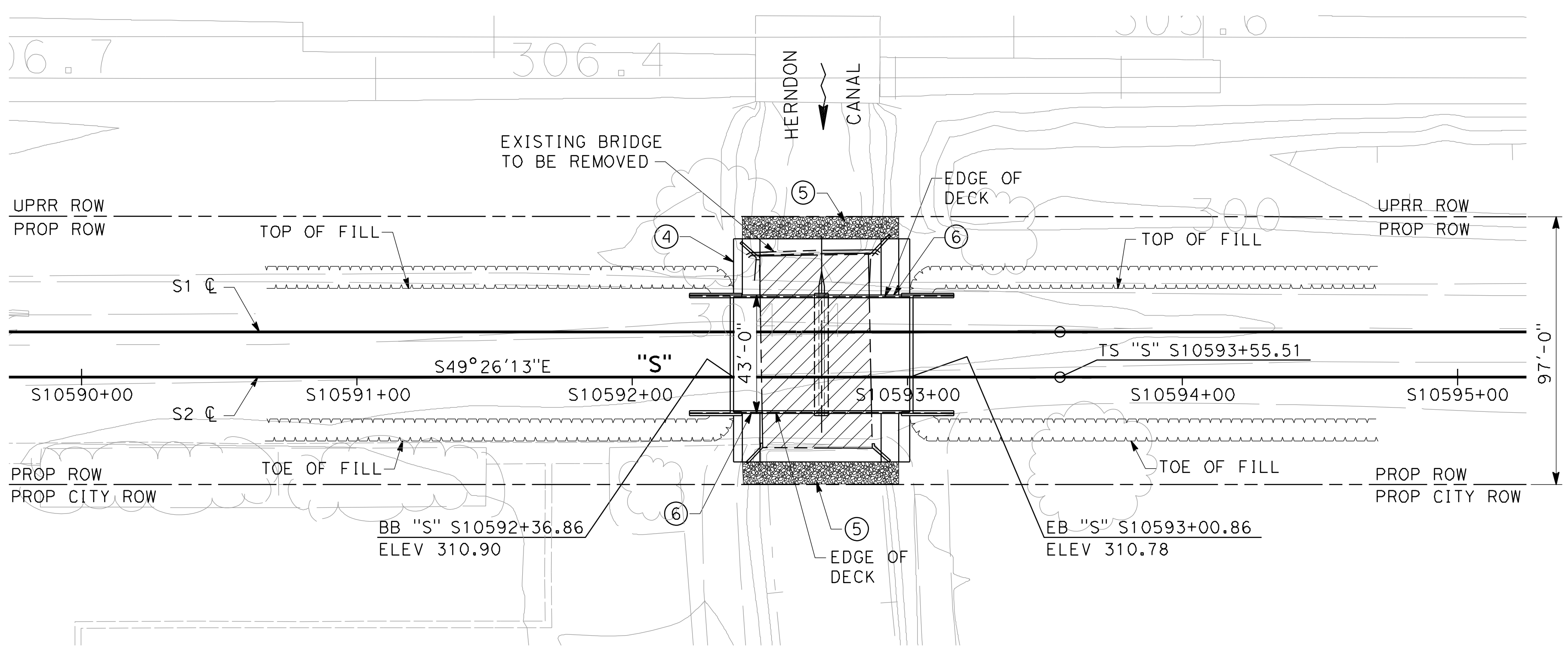
APPENDIX A- Preliminary Design Plans



TOP OF RAIL "S" LINE
NO SCALE



ELEVATION
SCALE: 1" = 30'

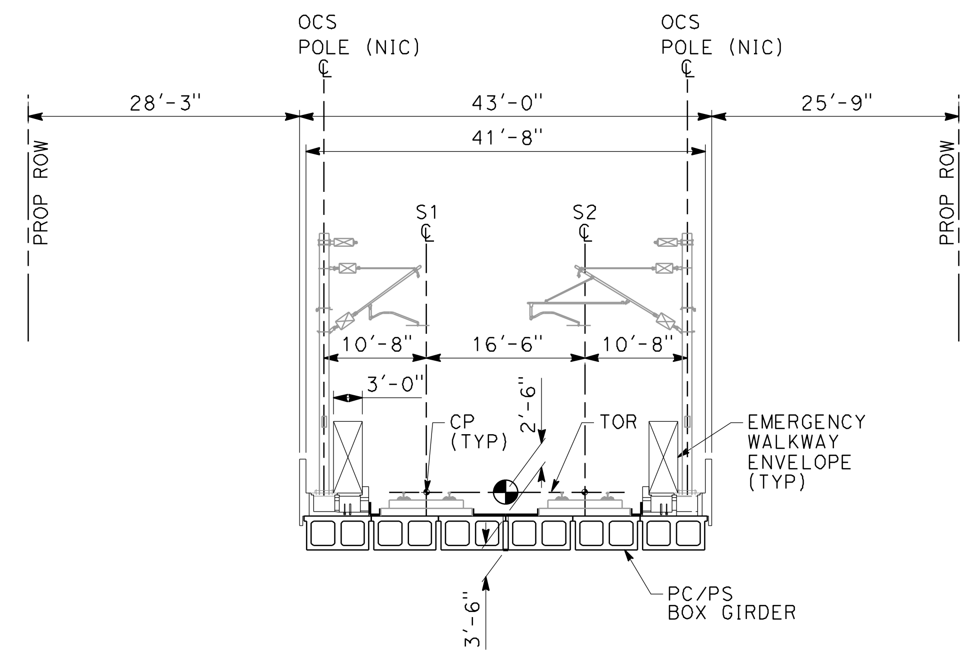


PLAN
SCALE: 1" = 30'

NOTES:

1. ROW SHOWN REPRESENTS THE MINIMUM ANTICIPATED ROW REQUIREMENTS. ACCURATE ROW AND ACCESS DATA WILL BE MADE AVAILABLE PRIOR TO NOTICE TO PROCEED.
2. OCS POSTS SHOWN ARE INDICATIVE ONLY AND MAY LOCATE OUTSIDE BRIDGE STRUCTURE.

3. PC/PS BOX GIRDER
4. CONCRETE CHANNEL LINING
5. ROCK SLOPE PROTECTION
6. PARAPET WALL BARRIER
7. CIDH CONCRETE PILE



TYPICAL SECTION
SCALE: 1" = 10'

REV	DATE	BY	CHK	APP	DESCRIPTION

DESIGNED BY H. LEE
DRAWN BY E. CISNEROS
CHECKED BY T. DUDLEY
IN CHARGE D. MINISTER
DATE 12/08/11

PROPOSED PRELIMINARY DESIGN

NOT FOR CONSTRUCTION

AECOM Technical Services, Inc.
2020 L Street, Suite 300
Sacramento, CA 95811
CH2MHILL

CALIFORNIA HIGH-SPEED RAIL AUTHORITY

CALIFORNIA HIGH-SPEED TRAIN PROJECT
SIERRA SUBDIVISION
PACKAGE 1A
TRACK STRUCTURES
HST BRIDGE AT HERNDON CANAL
GENERAL PLAN

CONTRACT NO.
DRAWING NO. ST-K1001
SCALE AS SHOWN
SHEET NO.

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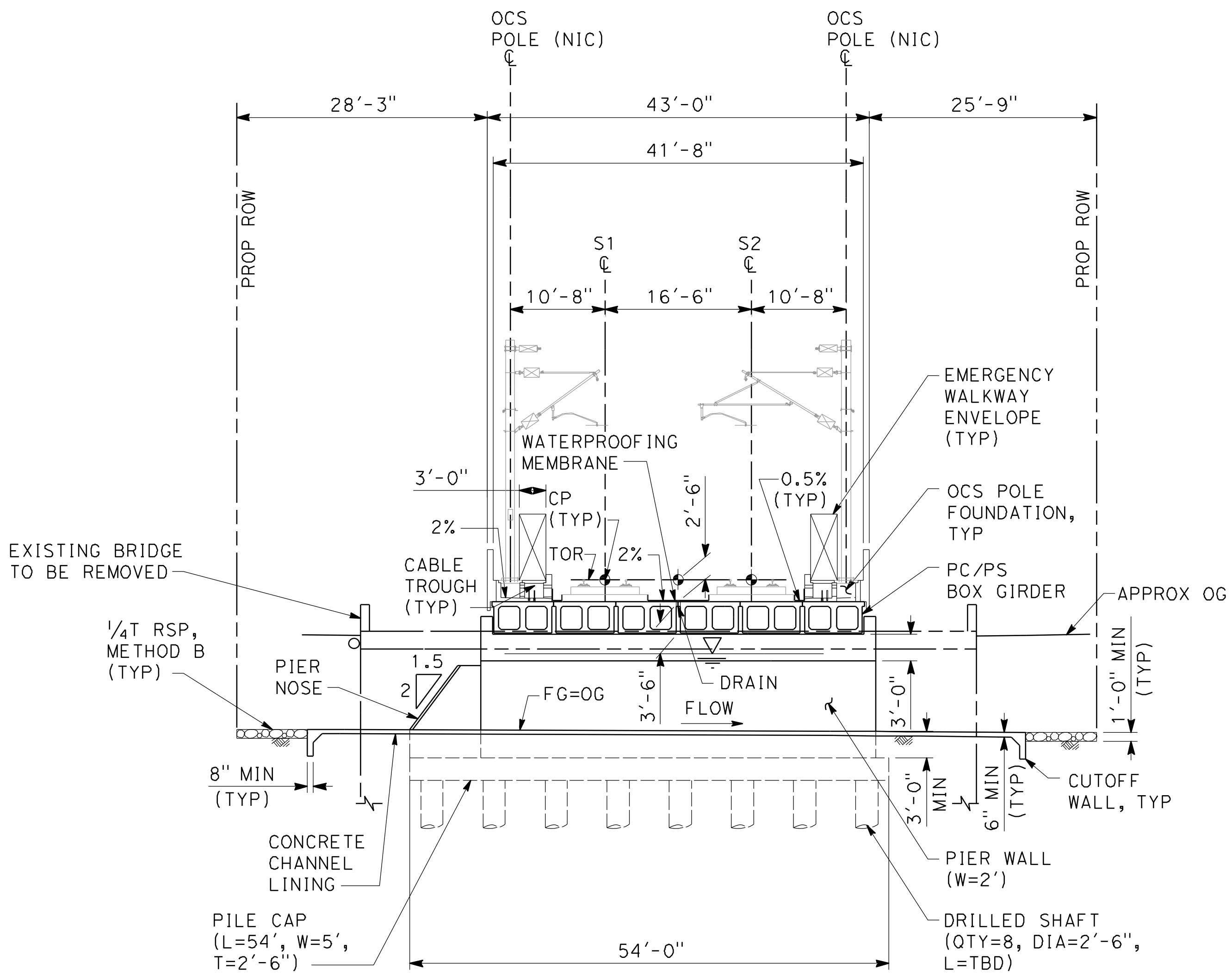
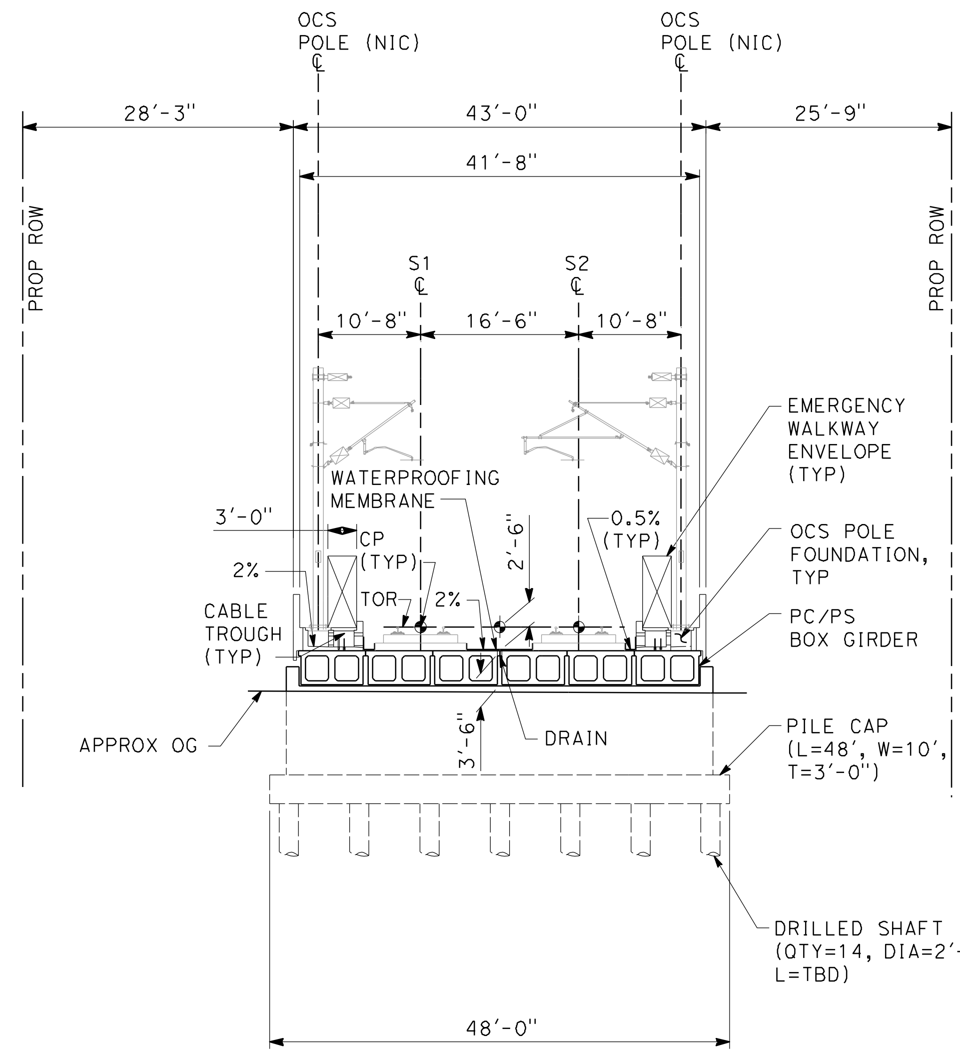
cisnerose

NOTES:

1. ROW SHOWN REPRESENTS THE MINIMUM ANTICIPATED ROW REQUIREMENTS. ACCURATE ROW AND ACCESS DATA WILL BE MADE AVAILABLE PRIOR TO NOTE TO PROCEED.
2. OCS POSTS SHOWN ARE INDICATIVE ONLY AND MAY LOCATE OUTSIDE BRIDGE STRUCTURE.
3. CUTOFF WALLS SHALL EXTEND ALONG CHANNEL BOTTOM & SIDES TO TOP OF SLOPE.



SECTION AT BENT 2



SECTION AT ABUTMENT 3

10 0 10 20
1"=10'
SCALE APPLICABLE FOR FULL SIZE ONLY

REV	DATE	BY	CHK	APP	DESCRIPTION

DESIGNED BY H. LEE
DRAWN BY E. CISNEROS
CHECKED BY T. DUDLEY
IN CHARGE D. MINISTER
DATE 12/08/11

PROPOSED PRELIMINARY DESIGN

NOT FOR CONSTRUCTION

AECOM Technical Services, Inc.
2020 L Street, Suite 300
Sacramento, CA 95811
CH2MHILL

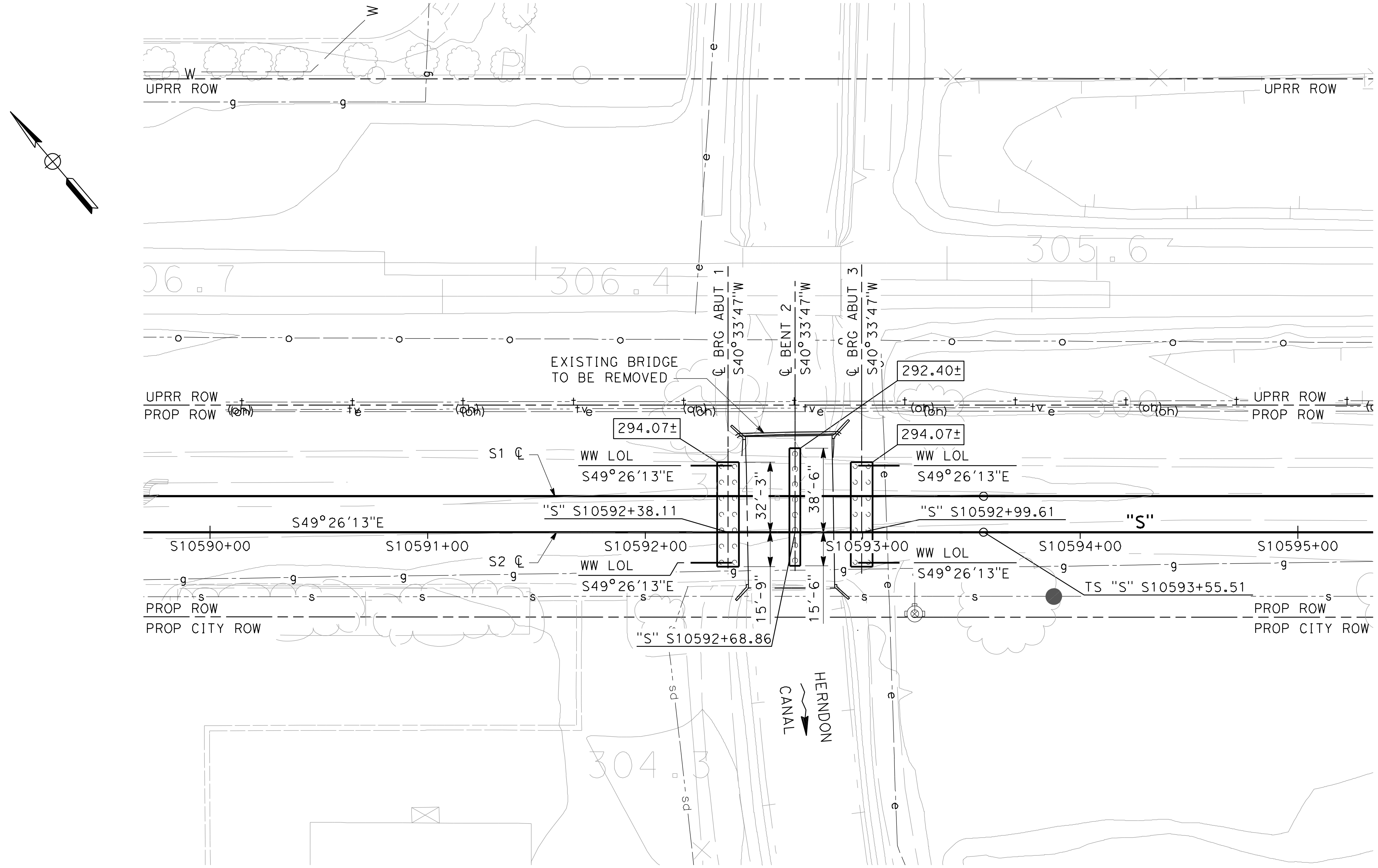
CALIFORNIA HIGH-SPEED RAIL AUTHORITY

CALIFORNIA HIGH-SPEED TRAIN PROJECT
SIERRA SUBDIVISION
PACKAGE 1A
TRACK STRUCTURES
HST BRIDGE AT HERNDON CANAL
TYPICAL SECTIONS

CONTRACT NO.
DRAWING NO. ST-K1002
SCALE AS SHOWN
SHEET NO.

NOTES:

1. ROW SHOWN REPRESENTS THE MINIMUM ANTICIPATED ROW REQUIREMENTS. ACCURATE ROW AND ACCESS DATA WILL BE MADE AVAILABLE PRIOR TO NOTICE TO PROCEED.
2. EXISTING BRIDGE AND UTILITY ARE APPROXIMATE.
3. EXISTING UNDERGROUND AND OVERHEAD UTILITIES TO BE DETERMINED.



PLAN
SCALE: 1" = 30'

REV	DATE	BY	CHK	APP	DESCRIPTION

DESIGNED BY H. LEE
DRAWN BY E. CISNEROS
CHECKED BY T. DUDLEY
IN CHARGE D. MINISTER
DATE 12/08/11

PROPOSED PRELIMINARY DESIGN

NOT FOR CONSTRUCTION

AECOM Technical Services, Inc.
2020 L Street, Suite 300
Sacramento, CA 95811
CH2MHILL

CALIFORNIA HIGH-SPEED RAIL AUTHORITY

CALIFORNIA HIGH-SPEED TRAIN PROJECT
SIERRA SUBDIVISION
PACKAGE 1A
TRACK STRUCTURES
HST BRIDGE AT HERNDON CANAL
FOUNDATION PLAN

CONTRACT NO.
DRAWING NO. ST-K1003
SCALE AS SHOWN
SHEET NO.

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APPENDIX B- Preliminary Design Calculations

CALIFORNIA HIGH-SPEED TRAIN

Structural Calculations

Preliminary Design Draft

Merced to Fresno Section

HST Herndon Canal Structural Design Calculations

November 2011

CALIFORNIA
High-Speed Rail Authority

U.S. Department of Transportation
Federal Railroad Administration

INDEX

Technical Task Protocol

Technical Task Protocol No.: S1 **Revision No.:** 1

Project: California High-Speed Train Project - Merced to Fresno

Job No.: 60162046.240105

Design Task Element: Preliminary Design for HST and Roadway Structures

Hohsing Lee 07/15/2011
Originator / Date

Mark Stiller 10/31/2011
Reviewer / Date

Objective

- This Technical Task Protocol addresses the production of preliminary design, calculations, and drawings of HST Herndon Canal Structure, GSB structure over the Herndon Canal, and Grade Separation of Shaw Avenue structure.

Prerequisites (Input)

- Required formats
  - All drawings will be done using Microstation V8 in English units.
  - Drawings will conform to Caltrans Memo to Designers (CMTD) 1-8 Advance Planning Studies and the CADD requirements set by the California High-Speed Rail Authority (CSHRA).
  - All drawings and calculations will be done in English units.
- Design Input from other HSR Design Teams
  - Topographic maps, scale and contour interval of maps and mapping files
  - Proposed horizontal profile each structure location
  - Supplementary field survey data
  - As-built drawings for existing overhead, overcrossing, aerial, and underpass structures and structure maintenance reports as available
  - DVD of Corridor for all subsections, major utility matrix, ROW, and easement line work
  - Preliminary geotechnical report
  - Field views of structure sites to be scheduled with the PM as required
  - Obtaining Utility base maps

Design

- Design criteria
  - Clearances at structures
    Horizontal Clearances:
    - No placing columns over the UPPR ROW

- 25’-0 horizontal clearances from CL nearest track to the face of column

Vertical Clearances:

- The HST Herndon Canal structure and GSB structure over Herndon Canal structure will provide a minimum of 2-ft free board measuring from mean high level water in the canal to the soffit of the structure.
- Shaw Avenue structure will provide the following minimum vertical clearance:
  - 27’ above top of rail over High-Speed Train railroad;
  - 24’-6” above top of rail over UPPR railroad;
  - 16’-6” over City Street and highways

- o Design Loads
  - Permanent loads shall be according to Section 6.4 TM 2.3.2 Rev.2.
  - For preliminary design, PMT directed us to assume 2-ft thick ballast for the calculations of loads regardless of ballasted or non-ballasted tracks. Maximum of ballast load or slab track is used.
  - Transient Loads and vertical impact effect shall be according to Section 6.5 TM 2.3.2 Rev.2 and Section 6.5.2 TM 2.10.10 Rev.0.

- Design Approach

  The following approach is to follow for developing the subject design task.
  - o Obtain input from others as required (see Section Prerequisites)
  - o Determine and document the bridge design criteria
  - o Configure/verify the bridge geometry, structure type and foundation type
  - o Develop structure typical sections, sizes of column and foundation
  - o Prepare the design loads per the design criteria
  - o Determine maximum seismic acceleration response for OBE at HST structure
  - o Verify the frequency requirements of HST structure
  - o Verify the vertical live load deflection of the HST structure
  - o Check the critical cases of relative longitudinal displacement at expansion joints for the HST structure
  - o Prepare preliminary VBridge or ConSpan design analysis to determine PT/PS and girder reactions.
  - o Perform VBent analysis for the design of bents and pier wall.
  - o Perform BRGABUT program for the design of HST abutments.
  - o Furnish initial pile reactions to Parikh for determination of the pile requirements

- Validated Software

  The following validated technical software is available to produce the subject design task.

No	Software	Description
1	ABUD*	Bridge abutment design
2	BRGABUT	Bridge abutment design
3	CONSPAN	PC/PS concrete longitudinal analysis
4	SAP2000*	Finite element analysis
5	SEISAB*	Seismic analysis of bridges
6	VBENT*	non-integral or integral piers or bents design
7	VBRIDGE*	Cast-in-place post-tensioned concrete bridge design
8	wFRAME*	Nonlinear static (pushover) analysis

Interdiscipline Coordination

- Obtain and review existing alignment and mapping data from civil group. Use as background data for plan and elevation views and right-of-way maps. Coordinate any additional required survey data through the PM.
- Coordinate with civil group on the proposed horizontal alignment of the new structure for each alternative.
- Provide information on preliminary superstructure depth and necessary falsework depths for all alternates being studied.
- Provide information on proposed locations and approximate sizes of substructure units.
- Coordinate with the civil group on the proposed profile of the baseline and the structure.
- Coordinate with the civil group on the proposed cross section of the bridge, including walkways and barriers.
- Coordinate with other teams to determine staging considerations.

References

- TM 1.1.21 Typical Cross Section For 15% Design
- TM 2.3.2 Structure Design Loads Rev.2
- TM 2.3.3 Design Guideline for High-Speed Train Aerial Structure
- TM 2.10.4 Seismic Design Criteria Rev.1
- TM 2.10.10 Track-Structure Interaction Rev.0
- Merced-Fresno Segment Design Spectra Response Curves from PMT
- Caltrans Memo to Designers
- Caltrans Bridge Design Specifications
- Caltrans Bridge Design Aid
- Caltrans Seismic Design Criteria (SDC), Version 1.6
- AREMA Section 17.3.3

JOB TITLE	CALIFORNIA HIGH-SPEED TRAIN PROJECT				
JOB NO.	60022962	CALCULATION NO.	1		
DIRECTED BY	HOHSING LEE	SHEET NO.	1	OF	7
ORIGINATOR	MARK STILLER	DATE	10/31/2011		
REVIEWER	TODD DUDLEY	DATE	11/3/2011		

SUBJECT: SHORT SPAN PRECAST ADJACENT BOX GIRDERS - HSR OVER HERNDON CANAL

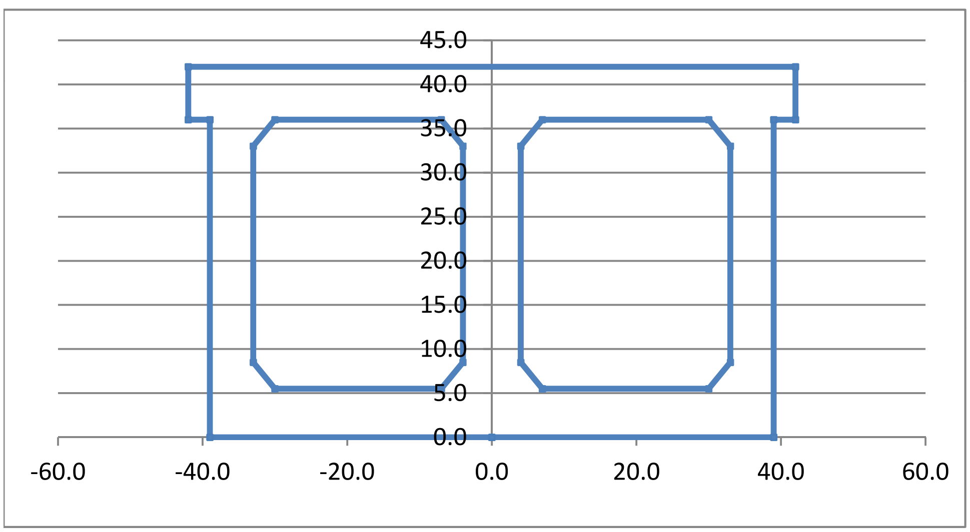
Materials and Load Combinations are per "GENERAL MATERIAL AND LOADING DATA" calculations sheet

Reference Technical Design Memos

Section Properties of Box Girders

Code	Value (in)	Description
a	84.0	Total width of top flange
b	42.0	Total section depth
c	3.0	Right overhang
d	3.0	Left overhang
e	6.0	Thickness of exterior girders
f	8.0	Thickness of interior girder
g	6.0	Thickness of top slab
h	5.5	Thickness of bottom slab
i	3.0	Bottom fillet width
j	3.0	Bottom fillet height
k	3.0	Top fillet width
l	3.0	Top fillet height

Coordinates of section		
Node	x	y
0	0.0	0.0
1	39.0	0.0
2	39.0	36.0
3	42.0	36.0
4	42.0	42.0
5	-42.0	42.0
6	-42.0	36.0
7	-39.0	36.0
8	-39.0	0.0
9	0.0	0.0
10	7.0	5.5
11	30.0	5.5
12	33.0	8.5
13	33.0	33.0
14	30.0	36.0
15	7.0	36.0
16	4.0	33.0
17	4.0	8.5
18	7.0	5.5
19	-7.0	5.5
20	-30.0	5.5
21	-33.0	8.5
22	-33.0	33.0
23	-30.0	36.0
24	-7.0	36.0
25	-4.0	33.0
26	-4.0	8.5
27	-7.0	5.5



Surface area =

39.00	23.00	23.00
36.00	4.24	4.24
3.00	24.50	24.50
6.00	4.24	4.24
84.00	23.00	23.00
6.00	4.24	4.24
3.00	24.50	24.50
36.00	4.24	4.24
39.00		

Total = 475.94 in

Volume/Area = 3.3176 in

Superstructure Section Properties:

Section No.	b	h	Area	Mom of I	y_b	$A * y_b^2$	$A * y_b$
	(in)	(in)	(in^2)	(in^4)	(in)	(in^4)	(in^3)
1	84.0	42.0	3528	518616.0	21.0	2E+06	74088
2	3.0	36.0	-108	-11664.0	18.0	-34992	-1944
3	3.0	36.0	-108	-11664.0	18.0	-34992	-1944
4	29.0	30.5	-884.5	-68567.2	20.8	-4E+05	-18353
5	29.0	30.5	-884.5	-68567.2	20.8	-4E+05	-18353
6	3.0	3.0	4.5	2.3	6.5	190.13	29.25
7	3.0	3.0	4.5	2.3	6.5	190.13	29.25
8	3.0	3.0	4.5	2.3	6.5	190.13	29.25
9	3.0	3.0	4.5	2.3	6.5	190.13	29.25
10	3.0	3.0	4.5	2.3	35.0	5512.5	157.5
11	3.0	3.0	4.5	2.3	35.0	5512.5	157.5
12	3.0	3.0	4.5	2.3	35.0	5512.5	157.5
13	3.0	3.0	4.5	2.3	35.0	5512.5	157.5
1	42.0	84.0	3528	2074464.0	42.0	6E+06	148176
2	36.0	3.0	-108	-81.0	1.5	-243	-162
3	36.0	3.0	-108	-81.0	82.5	-7E+05	-8910
4	30.5	29.0	-884.5	-61988.7	23.5	-5E+05	-20786
5	30.5	29.0	-884.5	-61988.7	60.5	-3E+06	-53512
6	3.0	3.0	4.5	2.3	10.0	450	45
7	3.0	3.0	4.5	2.3	37.0	6160.5	166.5
8	3.0	3.0	4.5	2.3	47.0	9940.5	211.5
9	3.0	3.0	4.5	2.3	74.0	24642	333
10	3.0	3.0	4.5	2.3	10.0	450	45
11	3.0	3.0	4.5	2.3	37.0	6160.5	166.5
12	3.0	3.0	4.5	2.3	47.0	9940.5	211.5
13	3.0	3.0	4.5	2.3	74.0	24642	333

Total area of section = 1579 in^2 10.965 ft^2

Properties about the Transverse Axis

Composite Moment of Inertia = 362689 in^4 17.5 ft^4
Composite Neutral Axis from bottom = 21.68 in 1.807 ft
Composite Section Modulus = 16726 in^3 9.6791 ft^3

Properties about the Vertical Axis

Composite Moment of Inertia = 1009490 in^4 48.683 ft^4
Composite Neutral Axis from right side = 42.00 in 3.50 ft
Composite Section Modulus = 24035 in^3 13.909 ft^3

Polar Moment of inertia = 1372180 in^4 66.174 ft^4 *Not factored for warping*

Torsional constant $K = \dfrac{2t\, t_1(a - t)^2(b - t_1)^2}{at + bt_1 - t^2 - t_1^2}$ for outer shell

t = 6.0 in
t_1 = 5.8 in
a = 78.0 in
b = 42.0 in

$K = ab^3(16/3 - 3.36b/a\ (1 - b^4/12a^4))$ for interior girder

a = 30.5 in
b = 8.0 in

K = 38.747 ft^4 For total section (neglecting overhangs)

Loading

Miscellaneous Dead Loads (DC/DW)

Dead Loads per TM 2.3.2

Total number of boxes for equivalent structure = 6 ea

	Full Section		Per Girder		
Cable tray, cables, and walkway:	3.20	kips/ft	0.53	kips/ft	
Soundwalls and parapet:	1.60	kips/ft	0.27	kips/ft	
OCS Poles and foundation:	0.63	kips/ft	0.11	kips/ft	
Rails and Fasteners:	0.40	kips/ft	0.07	kips/ft	
Max of Ballast or Slab Track:	7.98	kips/ft	1.33	kips/ft	(Per PMT, ballast load included on all HSR structures whether or not placement of ballast is planned)
Utilities/Miscellaneous:	0.10	kips/ft	0.02	kips/ft	

Total Additional Miscellaneous Dead Load = 2.319 kips/ft/girder

Live Load Definition (LLV)

The Cooper E50 load as defined in the "GENERAL MATERIAL AND LOADING DATA" calculations applies

Application of the rail load assumes a distribution through the ballast per AREMA specifications.

Width of box = 7 ft
Tie width = 9.0 ft
Ballast depth below tie = 1.3333 ft

Effective transverse distribution width of live load = 10.33 ft
Distance from CL track to CL box = 2.25 ft

Maximum width of distribution to a single box = 6.4167
Ratio of total rail width to single box distribution = 0.621 (number of track loads per girder)

Impact Factor (I)

80' span or less

$I = 40 - 3L^2/1600$

L = 29.0 ft

I = 38.423 %

Column capacity for the smaller spans will not be a controlling design issue for preliminary investigations therefore all other external loads are not considered in the adjacent box design

Deflection Calculation

Axle loads have been modified by the applicable live load distribution factor for Cooper E50 Loading

E50 Mod Axle	1	2	3	4	5	6	7	8	9
Load (kips)	15.524	31.048	31.048	31.048	31.048	20.181	20.181	20.181	20.181
Dist to BB (ft)	29	37	42	47	52	61	66	72	77

E50 Mod Axle	10	11	12	13	14	15	16	17	18	Trailing
Load (kips)	15.524	31.048	31.048	31.048	31.048	20.181	20.181	20.181	20.181	3.1048
Dist to BB (ft)	85	93	98	103	108	117	122	128	133	138

POI
Deflection at 0.5 x Span = 14.5 ft
Step Size 0.5 ft

Δ 1	Δ 2	Δ 3	Δ 4	Δ 5	Δ 6	Δ 7	Δ 8	Δ 9
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Δ 10	Δ 11	Δ 12	Δ 13	Δ 14	Δ 15	Δ 16	Δ 17	Δ 18	Trailing
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Total Deflection at POI 0.00 in

Maximum deflection of any step location = 0.0548 in
With impact included 0.0759 in

Deflection ratio = 4588

Axle loads have been modified by the applicable live load distribution factor for Cooper E50 Mod Loading

E50 Mod Axle	Leading	1	2	3	4	Trailing
Load (kips)	3.1048	31.048	31.048	31.048	31.048	3.1048
Dist to BB (ft)	29	31.5	36.5	41.5	46.5	49

POI

Deflection at 0.5 x Span = 14.5 ft

Step Size 0.5 ft

Leading	Δ 1	Δ 2	Δ 3	Δ 4	Trailing
0.031	0.000	0.000	0.000	0.000	0.000

Total Deflection at POI 0.0305 in

Maximum deflection of any step location = 0.0583 in

With impact included 0.0807 in

Deflection ratio = 4314 Min = 2200 **OK** 6.5.3

Deflection magnitude at 0.10 span : 0.0026 in

Deflection magnitude at 0.11 span : 0.0051 in

Difference = 0.0026 in

Distance of 0.01 span = 3.48 in

Angle of deflection at begin/end span = 0.7379 radians/1000 = 0.0423 degrees 2.10.10

Doubled at pier = 1.4758 radians Max = 1.7 **OK** 6.5.6

Frequencies of the structure:

$\omega_n = (n\pi)^2 \sqrt{(EI/\rho AL^4)}$

For the first natural frequency of vertical deflection:

$E =$ 4460 ksi

$I =$ 362689 in^4

$A =$ 1579 in^2

$L =$ 348.0 in

$\rho =$ 5.49E-07 x 1000 $slugs/in^3$ Additional unit wt for additional dead load

$n =$ 1 2.32 kips/ft

3.17E-07 $kips/in^3$

$\omega_1 =$ 111.34 rad/sec

$f_1 =$ 17.72 Hz 262.5/L limit = 9.0517 Hz **OK** 6.4.2

$230.46L^{-0.748}$ = 18.566 Hz **OK**

For the first natural frequency of transverse deflection:

E = 4460 ksi
I = 1009490 in^4
A = 1579 in^2
L = 348 in
ρ = 5.49E-07 x 1000 slugs/in^3
n = 1

ω_1 = 185.75 rad/sec
f_1 = 29.564 Hz Minimum = 1.2 **OK** 6.4.3

For the first natural frequency of torsional deflection:

$f_1 = n\pi \sqrt{(G/\rho)}/L$

ν = 0.2
G = 1858.3 ksi
L = 348 in
ρ = 5.49E-07 x 1000 slugs/in^3
n = 1

ω_1 = 525.29 Hz
f_1 = 83.603 Hz Minimum = 21.264 Hz **OK** 6.4.4

Longitudinal Displacements 6.6.3

Rotation at end of span = 0.0015 rad
Opening of structure at deck = 0.062 in Limit = 0.3 in **OK** 6.5.4.5.2(2)

Acceleration and braking absorbed by bearing pad, limited by restrainer as needed 6.5.4.5.2(1)
Assume at maximum allowable of 0.2 in

Max horiz acceleration at OBE = 0.185 g (MAX M-F Zone 1 OBE Horiz)
Abutment DL reaction = 740 kips
Mass of single span = 1480 kips
Longitudinal force = 273.8 kips
Transverse force = 82.14 kips
Total force = 355.94 kips

Width of abutment = 42 ft
Depth of abutment = 3.5 ft (effective)

Abutment spring (CSDC 7.8.1) = 1336.4 kips/in

Anticipated deflection = 0.2663 in Maximum = 0.5 in **OK** 6.6.3

Group 4: (LLRM+1) + LF = 0.32 in Maximum = 0.5 **OK**
Group 5: (LLRM+1) + LF +LDBE = 0.53 in Maximum = 1.0 **OK**

Rotational limitation

At abutment =	0.0075	rad	Calculated =	0.0015	rad	**OK**	6.6.3
At pier =	0.015	rad (both spans)	Calculated =	0.003	rad	**OK**	6.6.3

GEOMETRY DATA

BRIDGE LAYOUT

Overall Width (ft)	42.000
Left curb (ft)	0.000
Right curb (ft)	0.000
curb-to-curb width (ft)	42.000
Number of spans	1
Number of lanes	4
Lane width (ft)	12.000
Eff Deck thick (in)	0.000
Sacrificial thick (in)	0.000
Haunch thickness (in)	0.000
Haunch width (in)	0.000
Bridge c/s,MI(Ixx) (in4)	2224146.00

SPAN DATA

Precast length,	ft =	32.000
Bearing-to-bearing,	ft =	29.500
Release span,	ft =	31.000

BEAM DATA

No	ID	Loc-prev ft	Area in2	MI(Ixx) in4	Height in	Yb in	B-topg in	B-trib ft
1	42" Deep DBL Box	4.000	1594.0	370691.0	42.00	21.30	84.00	7.500
2	42" Deep DBL Box	7.000	1594.0	370691.0	42.00	21.30	84.00	7.000
3	42" Deep DBL Box	7.000	1594.0	370691.0	42.00	21.30	84.00	7.000
4	42" Deep DBL Box	7.000	1594.0	370691.0	42.00	21.30	84.00	7.000
5	42" Deep DBL Box	7.000	1594.0	370691.0	42.00	21.30	84.00	7.000
6	42" Deep DBL Box	7.000	1594.0	370691.0	42.00	21.30	84.00	6.500

MATERIAL DATA - Project Level

As defined in Material Tab. For beam level properties look at Beam Specific output.

CONCRETE PROPERTIES

	Precast	C.I.P
f'c (ksi)	6.000	4.000
Wc (pcf)	150.000	150.000
Ec (ksi)	4695.980	3834.250
K1	1.000	1.000

	Precast	C.I.P
f'ci (ksi)	4.500	
Eci (ksi)	4066.840	
K1	1.000	

STRAND AND REBAR PROPERTIES

PRESTRESSED STEEL:
6/10-270K-LL, Low relaxation strands
Depressed at 0.40L
Strand Diameter = 0.600 in
Tensile Strength(fpu) = 270.0 ksi
Use transformed strand and rebar: No

REINFORCING STEEL:
Tension/Shear steel: fy = 60.0 ksi Es = 29000 ksi fs = 24.0 ksi

LOADS DATA

Loads generated using Permanent Load Wizard: NO

LOADS ON PRECAST - NONE

DIAPHRAGM LOADS - NONE

LOADS ON COMPOSITE
UNITS: (Point: kips, Location: ft, Line: klf, Trapez: klf, Area: ksf, Width: ft)

Span	DC/DW	Type	Mag.1	Loc.1	Mag.2	Loc.2	Description
1	DC	Line	16.000	0.000	16.000	29.500	Misc DL

LIVE LOADS
Live load deflection: included.

ID	Type
Design Lane - not incl.	Design Lane
Design Tandem - not incl.	Design Tandem
CHSR E-50	Design Truck

LIVE LOADS USED

LIVE LOAD LIBRARY: default.cs3

1 ID: CHSR E-50	
Description:	High speed rail load
Type:	Design Truck

First Axle Magnitude = 25.00 k, Wheel Spacing = 4.75 ft, Truck Width = 10.00 ft

#	Magnitude, k	Max Spacing, ft	Min Spacing, ft	Increment, ft
1	50.00	8.00	8.00	0.00
2	50.00	5.00	5.00	0.00
3	50.00	5.00	5.00	0.00
4	50.00	5.00	5.00	0.00
5	32.50	9.00	9.00	0.00
6	32.50	5.00	5.00	0.00
7	32.50	6.00	6.00	0.00
8	32.50	5.00	5.00	0.00
9	25.00	8.00	8.00	0.00
10	50.00	8.00	8.00	0.00
11	50.00	5.00	5.00	0.00
12	50.00	5.00	5.00	0.00
13	50.00	5.00	5.00	0.00
14	32.50	9.00	9.00	0.00
15	32.50	5.00	5.00	0.00
16	32.50	6.00	6.00	0.00
17	32.50	5.00	5.00	0.00

2 ID: Fatigue Truck	
Description:	Fatigue Truck as in AASHTO-LRFD
Type:	Fatigue Truck

First Axle Magnitude = 8.00 k, Wheel Spacing = 6.00 ft, Truck Width = 10.00 ft

#	Magnitude, k	Max Spacing, ft	Min Spacing, ft	Increment, ft
1	32.00	14.00	14.00	0.00
2	32.00	30.00	30.00	0.00

PROPERTIES

Span: 1, Beam: 1

PRECAST DATA:

Section Id	42" Deep DBL Box	
Type	Adjacent Box Beam	
Flng width	Top 84.000 in	Bot 84.000 in
thick	Top 6.000 in	Bot 5.500 in
Stems	No 2	
	Top 10.000 in	
	Bot 10.000 in	
Shear width	20.000 in	

GENERAL BRIDGE DATA:

Bridge Width	42.00	ft
Curb-to-curb	42.00	ft
Beam Spac. Lt./Rt	4.00/ 7.00	ft
Lane width	12.00	ft
Number of lanes	4	
Interior/Exterior	Exterior	
Start Skew Angle	0.00	degrees
End Skew Angle	0.00	degrees

TOPPING DATA:

Deck	Thickness	0.000 in	
Haunch:			
	Thickness	0.000 in	
	Width	0.000 in	
Effective width		90.000 in	(Art. 4.6.2.6.1)

GENERAL LOAD DATA:

Dead loads on composite: See Project info for composite loads

GENERAL SPAN DATA:

Overall length	32.000	ft
Release length	31.000	ft
Design length	29.500	ft

KERN POINTS:

Upper	32.22	in
Lower	10.07	in

DISTRIBUTION FACTORS (Art. 4.6.2.2):

Live Moment	(2+ lanes loaded)	0.621	(Manual input)
Live Moment	(1 lane loaded)	0.621	(Manual input)
Live Shear	(2+ lanes loaded)	0.621	(Manual input)
Live Shear	(1 lane loaded)	0.621	(Manual input)

Pedestrian	0.179	(Manual input)
Dead Loads distributed based on Tributary Fraction		
Comp. DC	0.179	(Calculated)
Comp. DW	0.179	(Calculated)

RESISTANCE FACTORS (Art. 5.5.4.2):

Flexure Reinforced	
Compression controlled sections	0.75
Tension controlled sections	0.90
Flexure Prestressed	
Compression controlled sections	0.75
Tension controlled sections	1.00
Shear	0.90

Span: 1, Beam: 1

SECTION PROPERTIES:

	PRECAST		COMPOSITE		
Area	1594.0	in2	1594.0	in2	#
Total Height	42.00	in	42.00	in	
Mom. of Inertia (Ixx)	370691	in4	370691	in4	#
Ht. of c.g.	21.30	in	21.30	in	#
Density	150.00	pcf	150.00	pcf	
Self-weight	1660.4	plf	1660.4	plf	
Mom. of Inertia (Iyy)	1425490.1	in4			
Poisson's Ratio	0.2				

(#) Of Total Section using Ect/Ec = 0.8165

Use transformed strand and rebar: No

Span: 1, Beam: 1
STRESS LIMITS (Art. 5.9.4):

STRESS LIMITS AT RELEASE BEFORE LOSSES:

	PRECAST	
Strength	4.50	ksi
Elasticity	4066.8	ksi
Max comp	2.70	ksi
Max tens	-0.20	ksi
Max tens, w/reinf	-0.51	ksi

STRESS LIMITS AT FINAL AFTER LOSSES:

	PRECAST		DECK	
Strength	6.00	ksi	4.00	ksi
Elasticity	4695.98	ksi	3834.25	ksi

STRESS LIMITS AT FINAL 1 (P/S + DL + LL):

	PRECAST		DECK	
Max comp	3.60	ksi	2.40	ksi

STRESS LIMITS AT FINAL 2 (P/S + DL):

	PRECAST	DECK
Max comp	2.70 ksi	1.80 ksi

FATIGUE I STRESS LIMITS AT FINAL 3 (50% P/S + 50% DL + F_LL):

	PRECAST	DECK
Max comp	2.40 ksi	- ksi

SERVICE III (Tension):

DL+PS+LL		
	PRECAST	DECK
Max tens	-0.47 ksi	-0.38 ksi

DL+PS	
	PRECAST
Max tens	-0.00 ksi

Span: 1, Beam: 1

PRESTRESSED STEEL:

23 strands, 6/10-270K-LL, Low relaxation strands
Depressed at 0.40L (12.80 ft from member end)

END PATTERN (Ycg = 12.02 in):

17 @ 2.500 in 6 @ 39.000 in

Strand Diameter	0.600 in
Strand Area	0.217 in2
Total Strand Area	4.991 in2
Trans. Len,bonded	3.000 ft
Trans. Len,debonded	3.000 ft
Dev. Len, bonded	6.998 ft

Dev. Len, debonded	13.997	ft
Holddown Force	0.000	kips
Tensile Strength(fpu)	270.0	ksi
Initial Prestress = 0.75fpu	202.5	ksi
Initial Pull	1010.7	kips
Beam Shrtng (PL/AE)	0.058	in

REINFORCING STEEL:

Tension /Shear steel:		
fy	60.0	ksi
Es	29000	ksi
fs	24.0	ksi

LOSSES

Note: Values are calculated at Midspan

Str. area	4.9910	in2
Ycg	12.02	in
P_init	1010.7	kips
Ecc	9.28	in
Days to release	0.75	
Rel. Humid.(RH)	75.0	%
Es	28500.0	ksi
Eci	4067	ksi

AASHTO LOSSES

Elastic Shortening 5.54 ksi (Eq 5.9.5.2.3a-1), (fcgp= 0.791 ksi)

Elastic Gains	Gains	Adjustment
due to Precast Loads	-0.00 ksi	0.00 ksi
due to Composite Loads	-0.57 ksi	0.01 ksi
due to Live Loads	-1.25 ksi	0.04 ksi

Time Dependent Losses (Approximate Method (Art.5.9.5.3))

	Initial			Final		
Steel relaxation	0.00	ksi		2.40	ksi	(Eq 5.9.5.3-1)
Concrete shrinkage	0.00	ksi		10.36	ksi	(Eq 5.9.5.3-1)
Concrete creep	0.00	ksi		5.48	ksi	(Eq 5.9.5.3-1)
Sub-total	5.54	ksi	(2.74 %)	16.48	ksi	(8.14 %)
Total Prestress Losses				22.02	ksi	(10.87 %)

Prestressing Stress Limit Check (Table 5.9.3.1)

initial fpi = 202.5 ksi < 0.75 fpu, OK

initial fpe = 180.5 ksi < 0.80 fpy, OK

POSITIVE ENVELOPE STRESSES

Span : 1, Beam : 1, SERVICE I

RELEASE STRESSES, (ksi) (LOSS = 2.74 %)

	Trans	0.10L /0.90L	0.20L /0.80L	0.30L /0.70L	0.40L /0.60L	Midspan
Location, ft	2.50	2.70	5.90	9.10	12.30	15.50
Beam-Self						
Precast-top	0.040	0.043	0.082	0.111	0.128	0.134
Bottom	-0.041	-0.044	-0.085	-0.114	-0.132	-0.138
Prestress						
Precast-top	0.107	0.107	0.107	0.107	0.107	0.107
Bottom	1.141	1.141	1.141	1.141	1.141	1.141
Total						
Precast-top	0.147	0.150	0.190	0.218	0.235	0.241
Bottom	1.100	1.097	1.056	1.027	1.009	1.003

SERVICE I

POSITIVE ENVELOPE STRESSES, (ksi) (LOSS = 10.87 %)

	Bearing	Trans	H/2	0.10L /0.90L	0.20L /0.80L	0.30L /0.70L	0.40L /0.60L	Midspan
Location, ft	0.00	1.75	1.75	1.95	5.15	8.35	11.55	14.75
Prestress								
Precast-top	0.041	0.098	0.098	0.098	0.098	0.098	0.098	0.098
Bottom	0.436	1.045	1.045	1.045	1.045	1.045	1.045	1.045
Self wt.								
Precast-top	0.000	0.027	0.027	0.030	0.070	0.098	0.115	0.121
Bottom	-0.000	-0.028	-0.028	-0.031	-0.072	-0.101	-0.119	-0.125
DL-Prec (DC)								
Precast-top	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
Bottom	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
DL-Prec (DW)								

	Bearing	Trans	H/2	0.10L /0.90L	0.20L /0.80L	0.30L /0.70L	0.40L /0.60L	Midspan
Precast-top	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
Bottom	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
Diaphragm								
Precast-top	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
Bottom	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
Deck + Haunch								
Precast-top	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
Bottom	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
DL-Comp (DC)								
Precast-top	0.000	0.046	0.046	0.051	0.120	0.169	0.198	0.208
Bottom	-0.000	-0.048	-0.048	-0.053	-0.124	-0.174	-0.204	-0.214
DL-Comp (DW)								
Precast-top	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
Bottom	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
LL+I(+)								
Precast-top	-0.000	0.140	0.140	0.154	0.340	0.475	0.552	0.574
Bottom	-0.000	-0.144	-0.144	-0.159	-0.350	-0.489	-0.568	-0.591
Final 1 (P/S + DL + LL)								
Precast-top	0.041	0.312	0.312	0.334	0.628	0.841	0.964	1.002
Bottom	0.436	0.826	0.826	0.803	0.500	0.281	0.154	0.116
Final 2 (P/S + DL)								
Precast-top	0.041	0.172	0.172	0.180	0.288	0.366	0.412	0.428
Bottom	0.436	0.970	0.970	0.962	0.850	0.770	0.722	0.706

Span : 1, Beam : 1, SERVICE III

RELEASE STRESSES, (ksi) (LOSS = 2.74 %)

	Trans	0.10L /0.90L	0.20L /0.80L	0.30L /0.70L	0.40L /0.60L	Midspan
Location, ft	2.50	2.70	5.90	9.10	12.30	15.50
Beam-Self						
Precast-top	0.040	0.043	0.082	0.111	0.128	0.134
Bottom	-0.041	-0.044	-0.085	-0.114	-0.132	-0.138

	Trans	0.10L /0.90L	0.20L /0.80L	0.30L /0.70L	0.40L /0.60L	Midspan
Prestress						
Precast-top	0.107	0.107	0.107	0.107	0.107	0.107
Bottom	1.141	1.141	1.141	1.141	1.141	1.141
Total						
Precast-top	0.147	0.150	0.190	0.218	0.235	0.241
Bottom	1.100	1.097	1.056	1.027	1.009	1.003
As_top (in2)	0.000	0.000	0.000	0.000	0.000	0.000

SERVICE III

POSITIVE ENVELOPE STRESSES, (ksi) (LOSS = 10.87 %)

	Bearing	Trans	H/2	0.10L /0.90L	0.20L /0.80L	0.30L /0.70L	0.40L /0.60L	Midspan
Location, ft	0.00	1.75	1.75	1.95	5.15	8.35	11.55	14.75
Prestress								
Precast-top	0.041	0.098	0.098	0.098	0.098	0.098	0.098	0.098
Bottom	0.436	1.045	1.045	1.045	1.045	1.045	1.045	1.045
Self wt.								
Precast-top	0.000	0.027	0.027	0.030	0.070	0.098	0.115	0.121
Bottom	-0.000	-0.028	-0.028	-0.031	-0.072	-0.101	-0.119	-0.125
DL-Prec (DC)								
Precast-top	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
Bottom	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
DL-Prec (DW)								
Precast-top	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
Bottom	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
Diaphragm								
Precast-top	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
Bottom	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
Deck + Haunch								
Precast-top	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
Bottom	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000

	Bearing	Trans	H/2	0.10L /0.90L	0.20L /0.80L	0.30L /0.70L	0.40L /0.60L	Midspan
DL-Comp (DC)								
Precast-top	0.000	0.046	0.046	0.051	0.120	0.169	0.198	0.208
Bottom	-0.000	-0.048	-0.048	-0.053	-0.124	-0.174	-0.204	-0.214
DL-Comp (DW)								
Precast-top	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
Bottom	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
LL+I(+)								
Precast-top	-0.000	0.140	0.140	0.154	0.340	0.475	0.552	0.574
Bottom	-0.000	-0.144	-0.144	-0.159	-0.350	-0.489	-0.568	-0.591
Final 1 (P/S + DL + LL)								
Precast-top	0.041	0.312	0.312	0.334	0.628	0.841	0.964	1.002
Bottom	0.436	0.826	0.826	0.803	0.500	0.281	0.154	0.116
Final 2 (P/S + DL)								
Precast-top	0.041	0.172	0.172	0.180	0.288	0.366	0.412	0.428
Bottom	0.436	0.970	0.970	0.962	0.850	0.770	0.722	0.706

Span : 1, Beam : 1, FATIGUE I
POSITIVE ENVELOPE STRESSES, (ksi)

	Bearing	Trans	H/2	0.10L /0.90L	0.20L /0.80L	0.30L /0.70L	0.40L /0.60L	Midspan
Location, ft	0.00	1.75	1.75	1.95	5.15	8.35	11.55	14.75
F_LL+I(+)								
Precast-top	-0.000	0.048	0.048	0.053	0.122	0.169	0.195	0.200
Bottom	-0.000	-0.049	-0.049	-0.054	-0.125	-0.174	-0.201	-0.206
Final 3 (50% P/S + 50% DL + F_LL)								
Precast-top	0.021	0.134	0.134	0.142	0.266	0.352	0.402	0.414
Bottom	0.218	0.436	0.436	0.427	0.300	0.211	0.160	0.147

ULTIMATE MOMENT

ULTIMATE - Span : 1, Beam : 1, STRENGTH I
(Mr-prvd computed by AASHTO equations, Art. 5.7.3.2/5.7.3.3)

Location (ft) Mu k.ft	dp in	Aps in2	fps ksi	c in	a in	Mr-prvd k.ft	c/dt	Phi	1.2 Mcr k.ft	min Mr k.ft	Crkg Ratio	Mu-p/r Ratio
Transfer 1.75												
527.0	30.0	3.466	262.9	2.8	2.1	2195.6	0.067T	1.00	-	-	-	-
H/2 1.75												
527.0	30.0	3.466	262.9	2.8	2.1	2195.6	0.067T	1.00	-	-	-	-
0.1L 1.95												
581.7	30.0	3.542	262.7	2.9	2.2	2240.9	0.069T	1.00	-	-	-	-
0.2L 5.15												
1303.4	30.0	4.763	260.3	3.8	2.9	2947.9	0.091T	1.00	-	-	-	-
0.3L 8.35												
1827.0	30.0	4.991	259.9	4.0	3.0	3076.7	0.096T	1.00	3396.5	2429.9	1.1	1.68
0.4L 11.55												
2128.7	30.0	4.991	259.9	4.0	3.0	3076.7	0.096T	1.00	3396.5	2831.2	1.1	1.45
0.5L 14.75												
2219.3	30.0	4.991	259.9	4.0	3.0	3076.7	0.096T	1.00	3396.5	2951.7	1.1	1.39
0.6L 17.95												
2128.7	30.0	4.991	259.9	4.0	3.0	3076.7	0.096T	1.00	3396.5	2831.2	1.1	1.45
0.7L 21.15												
1827.0	30.0	4.991	259.9	4.0	3.0	3076.7	0.096T	1.00	3396.5	2429.9	1.1	1.68
0.8L 24.35												
1303.4	30.0	4.763	260.3	3.8	2.9	2947.9	0.091T	1.00	3396.5	1733.6	1.0	2.26
0.9L 27.55												
581.7	30.0	3.542	262.7	2.9	2.2	2240.9	0.069T	1.00	-	-	-	-
H/2 27.75												
527.0	30.0	3.466	262.9	2.8	2.1	2195.6	0.067T	1.00	-	-	-	-
Transfer 27.75												
527.0	30.0	3.466	262.9	2.8	2.1	2195.6	0.067T	1.00	-	-	-	-

Legend: C = Compression-Controlled (c/dt > 0.600)
I = In-Transition (0.60 >= c/dt > 0.375)
T = Tension-Controlled (c/dt <= 0.375)
Note : fr used for calculating Mcr is computed using AASHTO method (Art.5.4.2.6.)

ULTIMATE - Span : 1, Beam : 1, STRENGTH II
(Mr-prvd computed by AASHTO equations, Art. 5.7.3.2/5.7.3.3)

Bentley		AECOM-US	Sheet #	DS-16
			Job #	
Program:	LEAP® CONSPAN® V8i (SELECTseries 1)		By	
Version:	Version: 09.00.00.08	Copyright © Bentley Systems, Inc. 1984 - 2009	Date	Aug/15/2011
		www.bentley.com Phone: 1-800-778-4277	Checked	
File Name:	**Herndon Canal.csl**		Date	

Location (ft) Mu k.ft	dp in	Aps in2	fps ksi	c in	a in	Mr-prvd k.ft	c/dt	Phi	1.2 Mcr k.ft	min Mr k.ft	Crkg Ratio	Mu-p/r Ratio
Transfer 1.75												
527.0	30.0	3.466	262.9	2.8	2.1	2195.6	0.067T	1.00	-	-	-	-
H/2 1.75												
527.0	30.0	3.466	262.9	2.8	2.1	2195.6	0.067T	1.00	-	-	-	-
0.1L 1.95												
581.7	30.0	3.542	262.7	2.9	2.2	2240.9	0.069T	1.00	-	-	-	-
0.2L 5.15												
1303.4	30.0	4.763	260.3	3.8	2.9	2947.9	0.091T	1.00	-	-	-	-
0.3L 8.35												
1827.0	30.0	4.991	259.9	4.0	3.0	3076.7	0.096T	1.00	3396.5	2429.9	1.1	1.68
0.4L 11.55												
2128.7	30.0	4.991	259.9	4.0	3.0	3076.7	0.096T	1.00	3396.5	2831.2	1.1	1.45
0.5L 14.75												
2219.3	30.0	4.991	259.9	4.0	3.0	3076.7	0.096T	1.00	3396.5	2951.7	1.1	1.39
0.6L 17.95												
2128.7	30.0	4.991	259.9	4.0	3.0	3076.7	0.096T	1.00	3396.5	2831.2	1.1	1.45
0.7L 21.15												
1827.0	30.0	4.991	259.9	4.0	3.0	3076.7	0.096T	1.00	3396.5	2429.9	1.1	1.68
0.8L 24.35												
1303.4	30.0	4.763	260.3	3.8	2.9	2947.9	0.091T	1.00	3396.5	1733.6	1.0	2.26
0.9L 27.55												
581.7	30.0	3.542	262.7	2.9	2.2	2240.9	0.069T	1.00	-	-	-	-
H/2 27.75												
527.0	30.0	3.466	262.9	2.8	2.1	2195.6	0.067T	1.00	-	-	-	-
Transfer 27.75												
527.0	30.0	3.466	262.9	2.8	2.1	2195.6	0.067T	1.00	-	-	-	-

Legend: C = Compression-Controlled (c/dt > 0.600)
I = In-Transition (0.60 >= c/dt > 0.375)
T = Tension-Controlled (c/dt <= 0.375)
Note : fr used for calculating Mcr is computed using AASHTO method (Art.5.4.2.6.)

	Bearing	Trans.	H/2	0.10L	0.20L	0.30L	0.40L	MidSpan
Location, ft	0	1.75	1.75	1.95	5.15	8.35	11.55	14.75
Self wt. : M	0	40.3	40.3	44.6	104.1	146.6	172.1	180.6
V	24.5	21.6	21.6	21.3	15.9	10.6	5.3	0
DL-Prec. : M	0	0	0	0	0	0	0	0
(DC) V	0	0	0	0	0	0	0	0
DL-Prec. : M	0	0	0	0	0	0	0	0
(DW) V	0	0	0	0	0	0	0	0
Deck : M	0	0	0	0	0	0	0	0
+ Haunch V	0	0	0	0	0	0	0	0
Diaphragm : M	0	0	0	0	0	0	0	0
V	0	0	0	0	0	0	0	0
DL-Comp. : M	0	69.4	69.4	76.7	179.1	252.3	296.2	310.8
(DC) V	42.1	37.1	37.1	36.6	27.4	18.3	9.1	0
DL-Comp. : M	0	0	0	0	0	0	0	0
(DW) V	0	0	0	0	0	0	0	0
LL + I : M+	0	208.5	208.5	229.9	507	709.3	824	856.8
V	133.9	83.9	83.9	78.2	58.8	66.7	4.4	27.1
LL + I : M-	0	0	0	0	0	0	0	0
V	0	0	0	0	0	0	0	0
LL + I : Vmx	133.9	117.9	117.9	116.1	96.1	78.1	60.9	42.6
M	0	205.4	205.4	226.4	495.1	652	703.3	628.5
Pedestrian: M+	0	0	0	0	0	0	0	0
V	0	0	0	0	0	0	0	0
Pedestrian: M-	0	0	0	0	0	0	0	0
V	0	0	0	0	0	0	0	0
Pedestrian: Vmx	0	0	0	0	0	0	0	0
M	0	0	0	0	0	0	0	0

	0.60L	0.70L	0.80L	0.90L	H/2	Trans.	Bearing
Location, ft	17.95	21.15	24.35	27.55	27.75	27.75	29.5
Self wt. : M	172.1	146.6	104.1	44.6	40.3	40.3	0
V	5.3	10.6	15.9	21.3	21.6	21.6	24.5
DL-Prec. : M	0	0	0	0	0	0	0
(DC) V	0	0	0	0	0	0	0
DL-Prec. : M	0	0	0	0	0	0	0
(DW) V	0	0	0	0	0	0	0
Deck : M	0	0	0	0	0	0	0
+ Haunch V	0	0	0	0	0	0	0
Diaphragm : M	0	0	0	0	0	0	0
V	0	0	0	0	0	0	0
DL-Comp. : M	296.2	252.3	179.1	76.7	69.4	69.4	0
(DC) V	9.1	18.3	27.4	36.6	37.1	37.1	42.1
DL-Comp. : M	0	0	0	0	0	0	0
(DW) V	0	0	0	0	0	0	0
LL + I : M+	824	709.3	507	229.9	208.5	208.5	0
V	4.4	66.7	58.8	78.2	83.9	83.9	133.9
LL + I : M-	0	0	0	0	0	0	0
V	0	0	0	0	0	0	0
LL + I : Vmx	60.9	78.1	96.1	116.1	117.9	117.9	133.9
M	703.3	652	495.1	226.4	205.4	205.4	0
Pedestrian: M+	0	0	0	0	0	0	0
V	0	0	0	0	0	0	0
Pedestrian: M-	0	0	0	0	0	0	0
V	0	0	0	0	0	0	0
Pedestrian: Vmx	0	0	0	0	0	0	0
M	0	0	0	0	0	0	0

VBent

Bent Analysis

Version 3.3.2   8-4-2011

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AECOM

AASHTO LRFD Bridge Design Specifications
Fourth Edition, 2007
with 2008 Interim Revisions

and Caltrans Amendments, v3.06.01

Input Summary - Model Data

Bent Information Title of the Pier						
Spec	**Units**	**Locality**	**Design Mode**	**Seismic Zone**	**Support Type**	**Skew Angle**
LRFD	US	CA	Check	4	Simple	0.0 deg

Concrete Materials							
Name	**f'c / f'ci ksi**	**Density lb/ft^3**	**Exposure**	**Strain**	**Ec / Eci ksi**	**Dens Ec lb/ft^3**	
Concrete 1	4.00 3.50	150.00	0.7500	0.0030	3644.15 3408.79	145.00	init

Reinforcing Steel Materials				
Name	**fy ksi**		**Es ksi**	
Rebar 1	60.00		29000.00	

Oblong Shapes			
Name	**Width ft**	**Depth ft**	**# Points**
Oblong 1	45.000	1.500	26

Shape Properties				
Name	**Area ft^2**	**Ixx ft^4**	**Iyy ft^4**	**Torsion ft^4**
Oblong 1	67.017146	12.482880	11149.797072	45.178396
Name	**CG to Left ft**	**CG to Right ft**	**CG to Top ft**	**CG to Bottom ft**
Oblong 1	22.500000	22.500000	0.750000	0.750000

Deck Data					
Bridge Width ft	**Span Length (back) ft**	**Span Length (ahead) ft**	**Super Depth (back) ft**	**Super Depth (ahead) ft**	**Overhang ft**
42.000	35.000	35.000	6.500	6.500	3.500
Road Edge (left) ft	**Sidewalk (left) ft**	**Barrier (left) ft**	**Road Edge (right) ft**	**Sidewalk (right) ft**	**Barrier (right) ft**
8.000	0.000	0.000 outside	8.000	0.000	0.000 outside
Exposed Face	**Exposed Face**	**Frame Length**	**Frame Length**		**# Fix Supp**

(back) ft	(ahead) ft	(back) ft	(ahead) ft		
20.000	20.000	35.000	35.000		3

Line Type	Fixity	Offset in	Overhang ft	Grd #	Distance ft	To Deck Edge ft	Brg Height in
Back	Expan	-12.0	3.500	1	5.000	3.500	3.0
				2	12.000	10.500	3.0
				3	19.000	17.500	3.0
				4	26.000	24.500	3.0
				5	33.000	31.500	3.0
				6	40.000	38.500	3.0
Ahead	Expan	12.0	3.500	1	5.000	3.500	3.0
				2	12.000	10.500	3.0
				3	19.000	17.500	3.0
				4	26.000	24.500	3.0
				5	33.000	31.500	3.0
				6	40.000	38.500	3.0

Distance is measured from the left end of cap, along the cap
Deck Edge is measured from the left edge of deck, normal to the deck

Cap Data

Cap Length ft	Left Height ft		Concrete Material	Reinforcement Material
45.000	3.500		Concrete 1	Rebar 1

Shape Type		Width ft			
Rectangle		5.000			

Interior POI (even)	Exterior POI (even)		User POIs ft		Box End POIs
10	4		none		n/a

Location	Horz Dist ft	Vert Change ft	Location	Horz Dist ft	Vert Change ft
Top	45.000	0.000	Bot	45.000	0.000

Column Data

Col Num	Dist in Bent ft	Length ft	Rotation deg	Concrete Material	Reinforcement Material
1	22.500	12.500	0.00	Concrete 1	Rebar 1

Col Num	Shape Dst ft	Shape Name	Crack Factor	Top Face ft	Key Len ft	Key Wid ft
1	Bottom Top	Oblong 1 Oblong 1	1.0000	computed	0.000	0.000

Col Num	Connect Top	Connect Bottom	Eff Length K (long)	Eff Length K (tran)	Adjust Axial Load?	Adjustment Factor
1	Fix	Fix	2.0000	0.6500	No	0.0000

Col Num	Offset Dist ft	Offset Long ft	Offset Tran ft			Foundation
1		none				Footing 1

Col Num		Equal POIs	User POIs ft		Equal Nodes	User Nodes ft
1		1	none		1	none

Footing Data

Ftg Num	Footing Type	Under Column	Concrete Material	Reinforcement Material
1	pile	1	Concrete 1	Rebar 1

Ftg Num	Length ft	Width ft	Thickness ft	Offset (long) ft	Offset (tran) ft	Rotation deg
1	54.000	4.500	2.500	0.000	0.000	0.00

Pile Footing Data

Ftg Num	Capacity Type	Service kip	Strength kip	Strength Phi	Extreme kip	Extreme Phi
1	Compression Tension Lateral	375.000 110.000 50.000	500.000 150.000 80.000	0.7500 0.7500 1.0000	500.000 250.000	1.0000 1.0000

Ftg Num	Num Piles	Sect Dim in	First tran ft	First long ft	Last tran ft	Last long ft	Batter tran in	Batter long in
1	8	12.0	-23.000	0.000	23.000	0.000	0.0	0.0

Vertical batter dimension is 12.0 in

Input Summary - Load Data

Dead Load

Girder Number	Back Line Reaction kip	Ahead Line Reaction kip
Grd 1	152.000	0.000

Grd 2	152.000	0.000
Grd 3	152.000	0.000
Grd 4	152.000	0.000
Grd 5	152.000	0.000
Grd 6	152.000	0.000

Live Load Truck Data

Truck Name	Spec?	Axle #	Weight kip	Spacing ft
User Truck 1	User	1	156.000	

Design Vehicle
User Design Vehicle

Env #	Truck Name	Truck Impact	Neglect Axles ?	Lane Name	Lane Impact
1	User Truck 1	Yes	Yes		

Live Load Misc Data

Reaction Type	Truck Distrib	Truck Dist Datum		Pedestrian Load ksf	# Lanes Limit
computed	wheel line	uses truck distrib		0.075	2

Curve Radius ft			Speed Type	Speed Design mi/hr	Speed Permit mi/hr	Speed Fatigue mi/hr

0.0			spec	55.000	25.000	55.000

Live Load Factors							
Impact Type	**Impact Design**	**Impact Permit**	**Impact Fatigue**	**Centrif Factor**	**Braking Factor**	**MPF Reduct**	
user	1.3800	1.2500	1.1500	1.0000	1.0000	1.0000	

Truck and Lane Width Overrides				
Status	**Lane Width**	**Truck Width**	**Truck Gage**	**2 Lanes Limit**
User Override	15.000 ft	12.000 ft	4.750 ft	19.500 ft

Braking Force Overrides		
Truck Name	**Lane Name**	**Override kip**
User Truck 1		3.300

Water Flow and Levels					
Flow Direction	**Flow Angle deg**	**Loading Method**	**Water Level**	**Elevation ft**	**Velocity ft/sec**
L --> R	0.00	triangular	none	none	none

Water Pressure and Drag Overrides

Long Pressure ksf	Tran Pressure ksf	Drag Coef	Drag Coef Lateral	Drag Constant K
computed	computed	computed	computed	computed

Ice Load Data - Program Determined					
Ice Level ft	**Thickness in**	**Crush Stren ksf**	**Nose Angle deg**	**Frict Angle deg**	**b/t Ratio (LFD)**
0.000	6.00 (override)	58.000 (override)	0.00	0.00	1.0000 (computed)

Wind Pressure / Reaction Factors				
Description	**Factor**		**Description**	**Factor**
Wind On Super - Pressure	1.000		Wind On Sub - Cap Pressure	1.000
Wind On Super - Long Reaction	1.000		Wind On Sub - Column Pressure	1.000
Wind On Super - Tran Reaction	1.000		Wind On Sub - Shaft Pressure	1.000
			Wind On Sub - Strut Pressure	1.000
Wind On Live - Pressure	1.000			
Wind On Live - Long Reaction	1.000		Wind Overturning - Pressure	1.000
Wind On Live - Tran Reaction	1.000		Wind Overturning - Reaction	1.000

Wind Velocity and Angles			
Velocity Related Information	**Value**	**Wind Angles (default) deg**	**Wind Angles (user) deg**
Adjust for Structure Height?	No	60.00	n/a
		45.00	
Design Wind Velocity	100.00 mi/hr	30.00	
Default Angle?	Yes	15.00	
		0.00	
		-15.00	
		-30.00	

	-45.00 -60.00	

Footing - Pile Analysis

Pile Footing - Maximum Pile Forces - Strength									
Ftg Num	**Limit State**	**Load Case**	**Axial kip**	**Tran Moment kip-ft**	**Long Moment kip-ft**	**Pile Coord T ft**	**Pile Coord L ft**	**Pile Load kip**	**Ratio Pr/Pu**
1	STR-I	11	2104.6	4641.0	2101.9	23.00	0.00	321.9	1.16 OK
	STR-I	1	2104.6	4641.0	740.5	23.00	0.00	321.9	1.16 OK
	STR-I	6	2104.6	4641.0	740.5	23.00	0.00	321.9	1.16 OK
	STR-I	2	2104.6	-4641.0	740.5	-23.00	0.00	321.9	1.16 OK
	STR-I	3	2104.6	-4641.0	740.5	-23.00	0.00	321.9	1.16 OK

Pile Footing - Minimum Pile Forces - Strength									
Ftg Num	**Limit State**	**Load Case**	**Axial kip**	**Tran Moment kip-ft**	**Long Moment kip-ft**	**Pile Coord T ft**	**Pile Coord L ft**	**Pile Load kip**	**Ratio Pr/Pu**
1	STR-III	20	1081.1	1866.5	901.9	-23.00	0.00	111.5	3.36 OK
	STR-III	22	1081.1	1866.5	901.9	-23.00	0.00	111.5	3.36 OK
	STR-III	24	1081.1	1866.5	901.9	-23.00	0.00	111.5	3.36 OK
	STR-III	15	1081.1	-1866.5	901.9	23.00	0.00	111.5	3.36 OK
	STR-III	17	1081.1	-1866.5	901.9	23.00	0.00	111.5	3.36 OK

Pile Footing - Maximum Pile Forces - Service									
Ftg Num	**Limit State**	**Load Case**	**Axial kip**	**Tran Moment kip-ft**	**Long Moment kip-ft**	**Pile Coord T ft**	**Pile Coord L ft**	**Pile Load kip**	**Ratio Pr/Pu**
1	SER-I	1	1558.9	572.7	663.5	23.00	0.00	202.1	1.86 OK

	SER-I	2	1558.9	-572.7	663.5	-23.00	0.00	202.1	1.86 OK
	SER-I	20	1434.1	1727.1	1201.7	23.00	0.00	201.2	1.86 OK
	SER-I	21	1434.1	1727.1	1201.7	23.00	0.00	201.2	1.86 OK
	SER-I	22	1434.1	1727.1	1201.7	23.00	0.00	201.2	1.86 OK

Pile Footing - Minimum Pile Forces - Service

Ftg Num	Limit State	Load Case	Axial kip	Tran Moment kip-ft	Long Moment kip-ft	Pile Coord T ft	Pile Coord L ft	Pile Load kip	Ratio Pr/Pu
1	SER-I	20	1434.1	1727.1	1201.7	-23.00	0.00	157.4	2.38 OK
	SER-I	21	1434.1	1727.1	1201.7	-23.00	0.00	157.4	2.38 OK
	SER-I	22	1434.1	1727.1	1201.7	-23.00	0.00	157.4	2.38 OK
	SER-I	23	1434.1	1727.1	1201.7	-23.00	0.00	157.4	2.38 OK
	SER-I	24	1434.1	1727.1	1201.7	-23.00	0.00	157.4	2.38 OK

Pile Footing - Lateral Force Check

Ftg Num	Limit State	Load Case	Pri Col	Water Level	Load Dir	Group or Pile	Lateral Load kip	Lateral Resist kip	Ratio Res/Load
1	STR-III	1	1	n/a	comb	pile:	6.38	80.00	12.54 OK
	STR-III	21	1	n/a	comb	pile:	6.38	80.00	12.54 OK
	STR-III	23	1	n/a	comb	pile:	6.38	80.00	12.54 OK
	STR-III	20	1	n/a	comb	pile:	6.38	80.00	12.54 OK
	STR-III	22	1	n/a	comb	pile:	6.38	80.00	12.54 OK

```
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
*                                                               *
*                 P R O G R A M   B R G A B U T                 *
*                                                               *
*                        INPUT DATA ECHO                        *
*                                                               *
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
(Version  1.21)                              10/31/11, 12:29 pm

Input file  = Herndon Canal.in
Output file = Herndon Canal.out

O P T I O N S
=================================================================

Units           = English
Design Criteria = AASHTO (2002)
Concrete Design = Service Load Design (SLD)
Wall Type       = No Haunch
Footing Type    = Pile

P R O P E R T I E S
=================================================================

REINFORCED CONCRETE:

     MATERIAL PROPERTIES:

     Concrete compressive strength  = 4000.0 psi
     Concrete modulus of elasticity = 3604997.0 psi
     Concrete modulus of rupture    = 474.34 psi
     Concrete modular ratio         = 8
     Concrete unit weight           = 150.00 pcf
     Reinforcing yield strength     = 60000.0 psi
     Allowable stress factor        = 0.4

PILE RESISTANCE:

    -------------------------------------------------------------
    LOAD                RESISTANCE (kip)
                        SLS       ULS       EQ
    -------------------------------------------------------------
    Compression:        320.0     800.0     400.0
    Tension:            100.0     100.0     50.0
    Shear:              50.0      100.0     100.0
    -------------------------------------------------------------

PILE LATERAL LOAD - MOMENT DATA:

    -------------------------------------------------------------
    POINT     LATERAL LOAD        MOMENT
                 (kip)            (k-ft)
    -------------------------------------------------------------
      1       20.00               96.00
      2       30.00               145.00
      3       50.00               244.00
    -------------------------------------------------------------

FOOTING RESISTANCE:

    -------------------------------------------------------------
    PARAMETER                SLS       ULS       EQ
    -------------------------------------------------------------
```

```
    Passive coefficient:     0.300     0.300     0.300
    ------------------------------------------------------------

C O N F I G U R A T I O N
================================================================

WALL:

     Stem wall height       = 12.000 ft
     Stem wall length       = 50.000 ft
     Stem wall thickness    = 3.500 ft
     Stem wall batter       = 0.000 deg
     Back wall height       = 4.250 ft
     Back wall thickness    = 1.000 ft
     Seat width             = 2.500 ft
     Distance to CL bearing = 1.500 ft

FOOTING:

     Width of toe           = 3.500 ft
     Soil cover over toe    = 3.500 ft
     Footing width          = 10.000 ft
     Footing length         = 52.000 ft
     Footing thickness      = 3.000 ft

PILES:

     Pile width             = 2.0 in

    ------------------------------------------------------------
    ROW       TOE DIST  NO OF     NO OF     BATTER    SPACING
                (ft)    PILES     BATTER    (deg)       (ft)
    ------------------------------------------------------------
     1        2.000      7         0         0        8.000
     2        8.000      4         0         0        8.000
    ------------------------------------------------------------

L O A D S
================================================================

BRIDGE LOADS:

     Dead load constant        = 700.0 kip
     Dead load varying         = 40.0 kip
     Live load standard        = 320.0 kip
     Live load special         = 0.0 kip
     Live load long force      = 87.0 kip     at height = 0.500 ft
     Friction long force       = 10.0 kip     at height = 0.500 ft

EARTH LOADS:

     Lateral pressure coeff    = 0.290        at height = 0.333 H
     Earthquake pressure coeff = 0.000        at height = 0.000 H
     Compaction pressure       = 0.00 psf     at height = 0.000 ft
     Soil unit weight          = 120.00 pcf
     Surcharge pressure        = 850.00 psf

LOAD COMBINATIONS:

    ------------------------------------------------------------
    NO   LOAD CONDITION               MAXIMUM  MINIMUM  SERVICE
    ------------------------------------------------------------
```

1 Construction 1 - place superstructure before backfill

Dead load abutment	0	0	1
Dead load constant	0	0	1
Dead load varying	0	0	1

Service stress increase factor = 1.5

---

2 Construction 2 - place backfill before superstructure

Dead load abutment	0	0	1
Dead load earth	0	0	1
Lateral earth pressure	0	0	1

Service stress increase factor = 1.5

---

3 Group II - no live load on bridge

Dead load abutment	1.3	0.975	1
Dead load constant	1.3	0.975	1
Dead load varying	1.3	0.975	1
Dead load earth	1.3	0.975	1
Lateral earth pressure	1.69	1.69	1
Live load surcharge	1.69	0	1

Service stress increase factor = 1.25

---

4 Group I - live load on bridge

Dead load abutment	1.3	0.975	1
Dead load constant	1.3	0.975	1
Dead load varying	1.3	0.975	1
Dead load earth	1.3	0.975	1
Live load standard	2.171	2.171	1
Live load longitudinal force	2.171	2.171	1
Lateral earth pressure	1.69	1.69	1
Live load surcharge	1.69	0	1

Service stress increase factor = 1

---

5 Group V - no live load with bearing friction

Dead load abutment	1.25	0.937	1
Dead load constant	1.25	0.937	1
Dead load varying	1.25	0.937	1
Dead load earth	1.25	0.937	1
Friction longitudinal force	1.25	1.25	1
Lateral earth pressure	1.25	1.25	1
Live load surcharge	1.25	0	1

Service stress increase factor = 1.4

---

6 Group IV - live load with bearing friction

Dead load abutment	1.3	0.975	1
Dead load constant	1.3	0.975	1
Dead load varying	1.3	0.975	1
Dead load earth	1.3	0.975	1

Live load standard	1.3	1.3	1
Live load longitudinal force	1.3	1.3	1
Friction longitudinal force	1.3	1.3	1
Lateral earth pressure	1.69	1.69	1
Live load surcharge	1.69	0	1

Service stress increase factor = 1.25

R E I N F O R C I N G
===

LOCATION	AREA (in^2)	SPACING (in)	COVER (in)
Wall stem	1.00	6.00	2.00
Backwall	1.00	6.00	
Footing top	1.00	6.00	3.00
Footing bottom at toe	1.00	6.00	6.00
Footing bottom at heel	1.00	6.00	
Footing long w/piles	1.00	6.00	
T&S in wall stem	1.00	6.00	
T&S in backwall	1.00	6.00	
T&S in footing	1.00	6.00	

```
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
*                                                               *
*                P R O G R A M   B R G A B U T                  *
*                                                               *
*                         OUTPUT DATA                           *
*                                                               *
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
```

B A C K W A L L
===

UNFACTORED LOADS:

LOAD CONDITION	SHEAR (kip/ft)	MOMENT (k-ft/ft)
Lateral earth pressure	0.209	0.445
Surcharge pressure	0.854	2.226

SERVICEABILITY LIMIT STATE CALCULATIONS:

SHEAR (Comb 4):

Effective depth = 9.44 in
Service shear = 1.063 kip/ft
d required = 1.47 < d provided = 9.44 OKAY

MOMENT (Comb 4):

Service moment = 2.671 k-ft/ft
Steel stress = 1966.35 < Allowable stress = 24000.00 OKAY
Concrete stress = 169.94 psi

TEMPERATURE AND SHRINKAGE:

T&S reinforcement = 1.00 > Area required = 0.06 OKAY

S T E M   W A L L

UNFACTORED LOADS:

LOAD CONDITION	SHEAR (kip/ft)	MOMENT (k-ft/ft)
Dead load constant		3.500
Dead load varying		0.200
Live load standard		1.600
LL longitudinal force	1.740	14.355
FR longitudinal force	0.200	1.650
Lateral earth pressure	1.321	10.022
Surcharge pressure	2.148	17.748

SERVICEABILITY LIMIT STATE CALCULATIONS:

SHEAR (Comb 4):

Effective depth = 39.44 in
Service shear   = 5.209 kip/ft
d required   = 7.22 < d provided = 39.44 OKAY

MOMENT (Comb 4):

Service moment = 47.425 k-ft/ft
Steel stress   = 7810.24 < Allowable stress = 24000.00 OKAY
Concrete stress = 289.02 psi

TEMPERATURE AND SHRINKAGE:

T&S reinforcement = 1.00 > Area required = 0.06 OKAY

REQUIRED REINFORCEMENT AREA IN STEM WALL SECTIONS:
(Service Load Design)

HEIGHT (ft)	THICK (in)	deff (in)	MOMENT (k-ft/ft)	AREA (in^2)	LOAD COMB
11.23	42.00	39.44	42.04	0.30	4
10.45	42.00	39.44	37.04	0.27	4
9.68	42.00	39.44	32.40	0.23	4
8.90	42.00	39.44	28.11	0.20	4
8.13	42.00	39.44	24.16	0.17	4
7.35	42.00	39.44	20.53	0.15	4
6.58	42.00	39.44	17.19	0.12	4
5.80	42.00	39.44	14.14	0.10	4
5.03	42.00	39.44	11.37	0.08	4
4.25	42.00	39.44	8.84	0.06	4

S T A B I L I T Y

UNFACTORED WEIGHT AND RIGHTING MOMENT:

LOAD CONDITION	WEIGHT (kip)	MOMENT AT TOE (k-ft)
Dead load abutment	469.3	2445.2
Dead load constant	700.0	3500.0
Dead load varying	40.0	200.0
Dead load earth	292.4	1969.8
Live load standard	320.0	1600.0
Live load surcharge	127.5	1083.8

UNFACTORED LATERAL FORCE AND OVERTURNING MOMENT:

LOAD CONDITION	FORCE (kip)	MOMENT AT TOE (k-ft)
LL longitudinal force	87.0	978.8
FR longitudinal force	10.0	112.5
Lateral earth pressure	195.7	977.8
Surcharge pressure	184.9	1386.6

RESULTANT LOAD COMBINATIONS:

COMB NO	LIMIT STATE	VERTICAL LOAD (kip)	RIGHTING MOMENT (k-ft)	LATERAL LOAD (kip)	OVERTURNING MOMENT (k-ft)
1	SLS	1209.3	6145.2	0.0	0.0
2	SLS	761.7	4415.0	195.7	977.8
3	SLS	1629.2	9198.7	380.6	2364.3
4	SLS	1949.2	10798.7	467.6	3343.1
5	SLS	1629.2	9198.7	390.6	2476.8
6	SLS	1949.2	10798.7	477.6	3455.6

VERTICAL RESULTANT:

COMB NO	LIMIT STATE	CASE NO	VERTICAL LOAD (kip)	TOE DISTANCE (ft)	RESULTANT LOCATION
1	SLS	-	1209.3	5.082	-0.016
2	SLS	-	761.7	4.512	0.098
3	SLS	-	1629.2	4.195	0.161
4	SLS	-	1949.2	3.825	0.235
5	SLS	-	1629.2	4.126	0.175

6	SLS	-	1949.2	3.767	0.247

P I L E   F O O T I N G

PILE GROUP PROPERTIES:

Number of piles = 11
Pile CG distance = 4.182 ft
Pile group inertia = 9.164E+01 ft^2

PILE LOADS:

COMB NO	LIMIT STATE	PILE ROW	VERTICAL LOAD (kip)	SHEAR LOAD (kip)	BENDING MOMENT (k-ft)
1	SLS	1	84.0	0.0	0.0
		2	155.3	0.0	0.0
2	SLS	1	79.1	12.6	60.5
		2	52.0	12.6	60.5
3	SLS	1	185.9	30.3	146.4
		2	81.9	30.3	146.4
4	SLS	1	243.5	39.1	189.8
		2	61.2	39.1	189.8
5	SLS	1	189.1	30.7	148.3
		2	76.3	30.7	148.3
6	SLS	1	246.2	39.1	190.0
		2	56.4	39.1	190.0

MAXIMUM PILE LOADS:

SLS Compression (Comb 4) = 243.5 < 320.0 OKAY
SLS Shear (Comb 4) = 39.1 < 50.0 OKAY
SLS Moment (Comb 4) = 189.8

LATERAL STABILITY:

COMB NO	LIMIT STATE	FORCE (kip)	RESISTANCE (kip)	
1	SLS	0.0	882.0	OKAY
2	SLS	195.7	882.0	OKAY
3	SLS	380.6	735.0	OKAY
4	SLS	467.6	588.0	OKAY
5	SLS	390.6	823.2	OKAY

```
    6        SLS       477.6     735.0     OKAY

    -------------------------------------------------------------

FOOTING LOADS:

    -------------------------------------------------------------
    COMB   LIMIT  CASE   TOE       TOE       HEEL       HEEL
     NO    STATE   NO   SHEAR     MOMENT    SHEAR     MOMENT
                        (kip/ft)  (k-ft/ft) (kip/ft)  (k-ft/ft)
    -------------------------------------------------------------

     1     SLS     -    -0.471    14.211    -0.246    9.919

     2     SLS     -    -0.911    2.497     -1.034    0.151

     3     SLS     -    -0.911    12.512    -1.499    5.231

     4     SLS     -    -0.911    18.284    -1.499    6.980

     5     SLS     -    -0.911    12.895    -1.499    4.951

     6     SLS     -    -0.911    18.806    -1.499    6.629
    -------------------------------------------------------------

    SIGN CONVENTION:

         Positive moment => tension on bottom of footing
         Positive shear  => upward direction

-------------------------------------------------------------
F O O T I N G   T O E
-------------------------------------------------------------

SERVICEABILITY LIMIT STATE CALCULATIONS:

     SHEAR (Comb 4):

     Effective depth = 32.44 in
     Service shear   = 0.911 kip/ft
     d required      = 1.26 < d provided = 32.44 OKAY

     TENSION AT FOOTING BOTTOM:
     -----------------------------

     MOMENT (Comb 4):

     Service moment  = 18.284 k-ft/ft
     Steel stress    = 4079.12 < Allowable stress = 24000.00 OKAY
     Concrete stress = 178.29 psi

     NO TENSION AT FOOTING TOP:
     -----------------------------

-------------------------------------------------------------
F O O T I N G   H E E L
-------------------------------------------------------------

SERVICEABILITY LIMIT STATE CALCULATIONS:

     SHEAR (Comb 4):

     Effective depth = 32.44 in
```

```
     Service shear   = 1.499 kip/ft
     d required      = 2.08 < d provided = 32.44 OKAY

     TENSION AT FOOTING BOTTOM:
     -----------------------------

     MOMENT (Comb 4):

     Service moment  = 6.980 k-ft/ft
     Steel stress    = 1557.31 < Allowable stress = 24000.00 OKAY
     Concrete stress = 68.07 psi

     NO TENSION AT FOOTING TOP:
     -----------------------------

     TEMPERATURE AND SHRINKAGE:

     T&S reinforcement = 1.00 > Area required = 0.06 OKAY

-------------------------------------------------------------
L O N G I T U D I N A L   R E I N F O R C E M E N T
-------------------------------------------------------------

SLS CALCULATIONS FOR FOOTING TOE:

     Pressure = 6555.4 psf
     Spacing  = 8.000 ft

     MOMENT (Comb 4):

     Service moment  = 41.954 k-ft/ft
     Steel stress    = 9748.54 < Allowable stress = 24000.00 OKAY
     Concrete stress = 435.79 psi

SLS CALCULATIONS FOR FOOTING HEEL:

     Pressure = 2740.0 psf
     Spacing  = 8.000 ft

     MOMENT (Comb 4):

     Service moment  = 17.536 k-ft/ft
     Steel stress    = 4074.67 < Allowable stress = 24000.00 OKAY
     Concrete stress = 182.15 psi
```